FIG.1

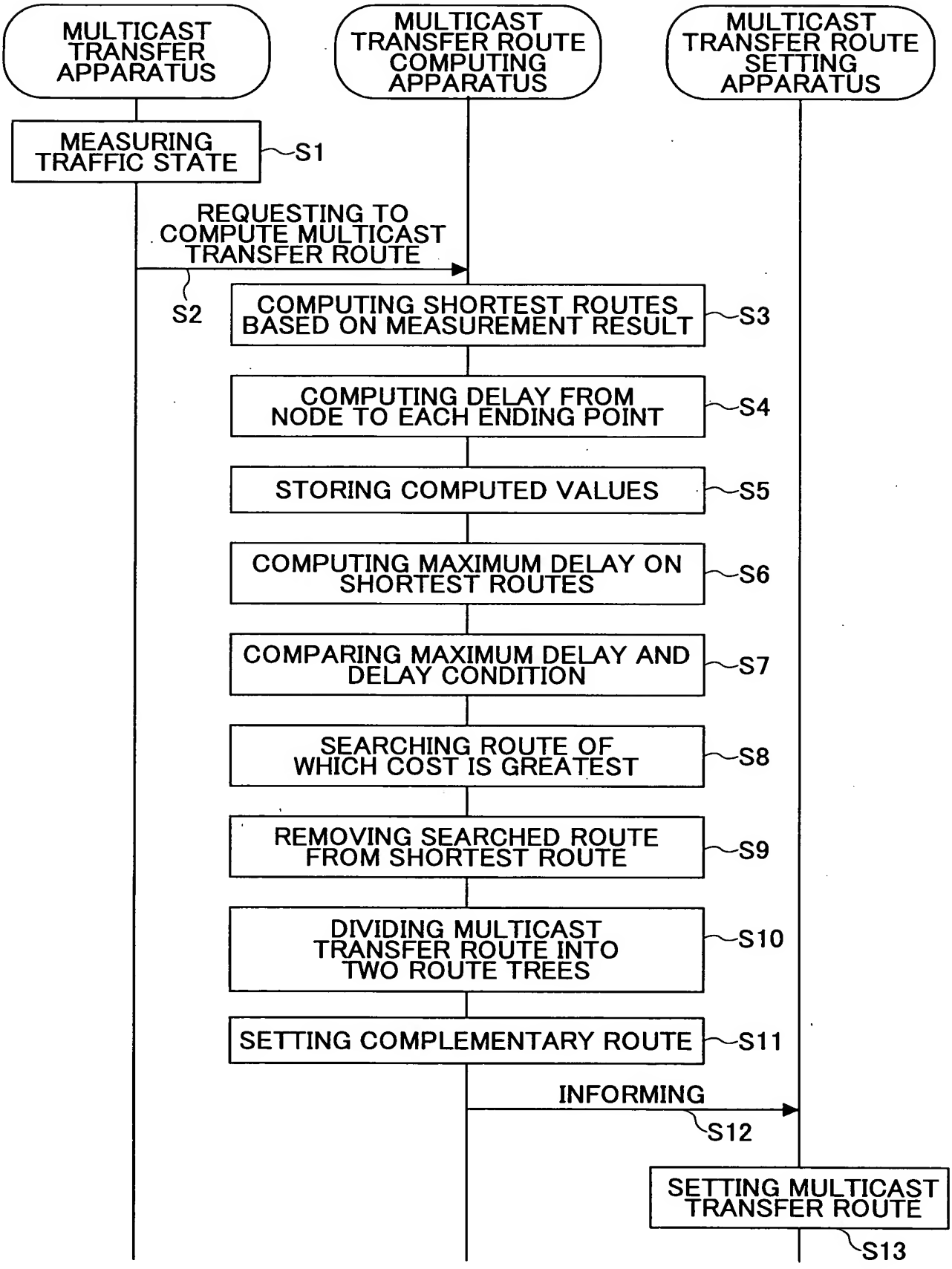

MULTICAST TRANSFER APPARATUS
MULTICAST TRANSFER ROUTE COMPUTING APPARATUS
MULTICAST TRANSFER ROUTE SETTING APPARATUS
MEASURING TRAFFIC STATE
S1
REQUESTING TO COMPUTE MULTICAST TRANSFER ROUTE
S2
COMPUTING SHORTEST ROUTES BASED ON MEASUREMENT RESULT
S3
COMPUTING DELAY FROM NODE TO EACH ENDING POINT
S4
STORING COMPUTED VALUES
S5
COMPUTING MAXIMUM DELAY ON SHORTEST ROUTES
S6
COMPARING MAXIMUM DELAY AND DELAY CONDITION
S7
SEARCHING ROUTE OF WHICH COST IS GREATEST
S8
REMOVING SEARCHED ROUTE FROM SHORTEST ROUTE
S9
DIVIDING MULTICAST TRANSFER ROUTE INTO TWO ROUTE TREES
S10
SETTING COMPLEMENTARY ROUTE
S11
INFORMING
S12
SETTING MULTICAST TRANSFER ROUTE
S13

FIG.2

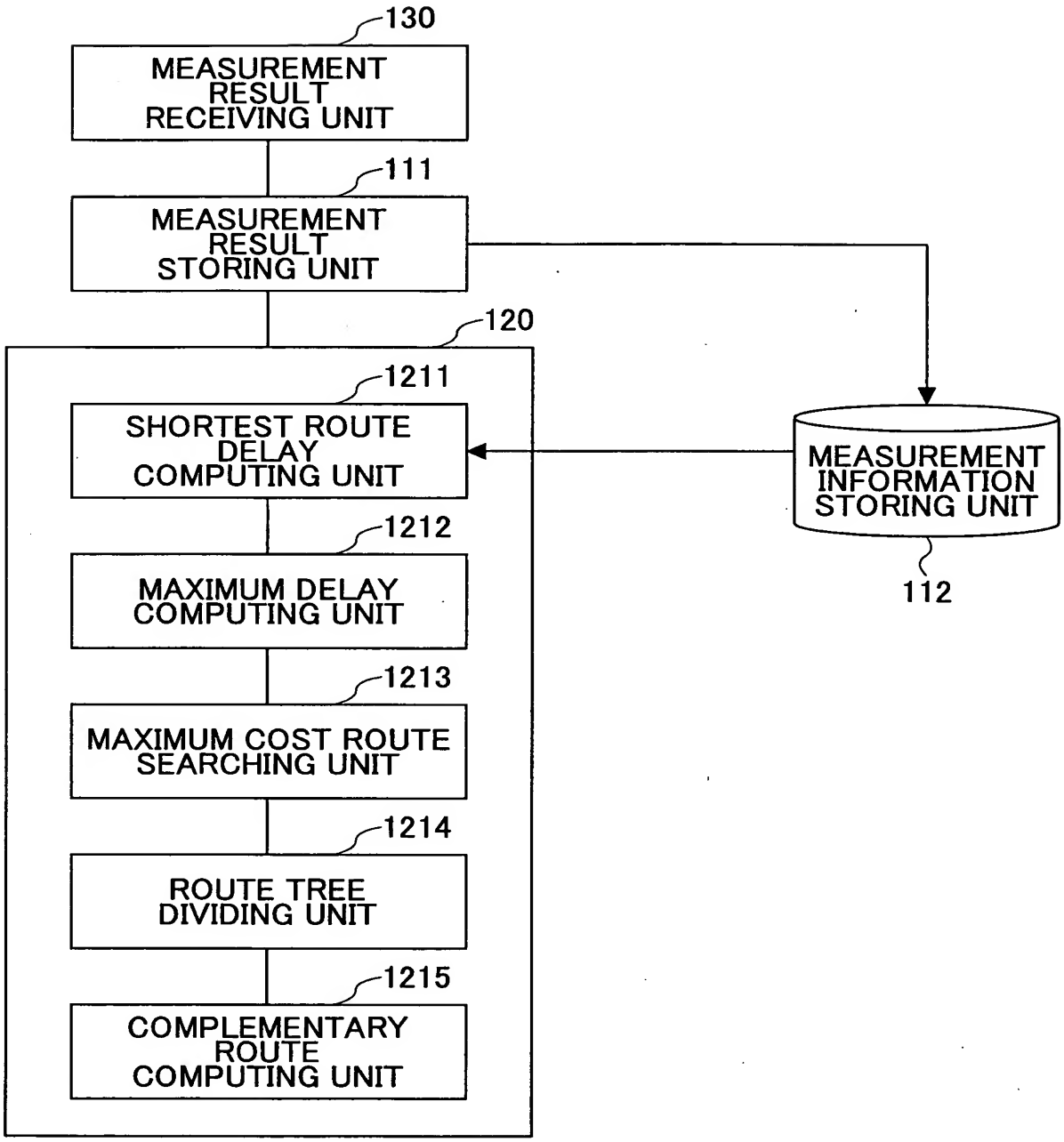

130
MEASUREMENT RESULT RECEIVING UNIT
111
MEASUREMENT RESULT STORING UNIT
120
1211
SHORTEST ROUTE DELAY COMPUTING UNIT
1212
MAXIMUM DELAY COMPUTING UNIT
1213
MAXIMUM COST ROUTE SEARCHING UNIT
1214
ROUTE TREE DIVIDING UNIT
1215
COMPLEMENTARY ROUTE COMPUTING UNIT
MEASUREMENT INFORMATION STORING UNIT
112

FIG.3

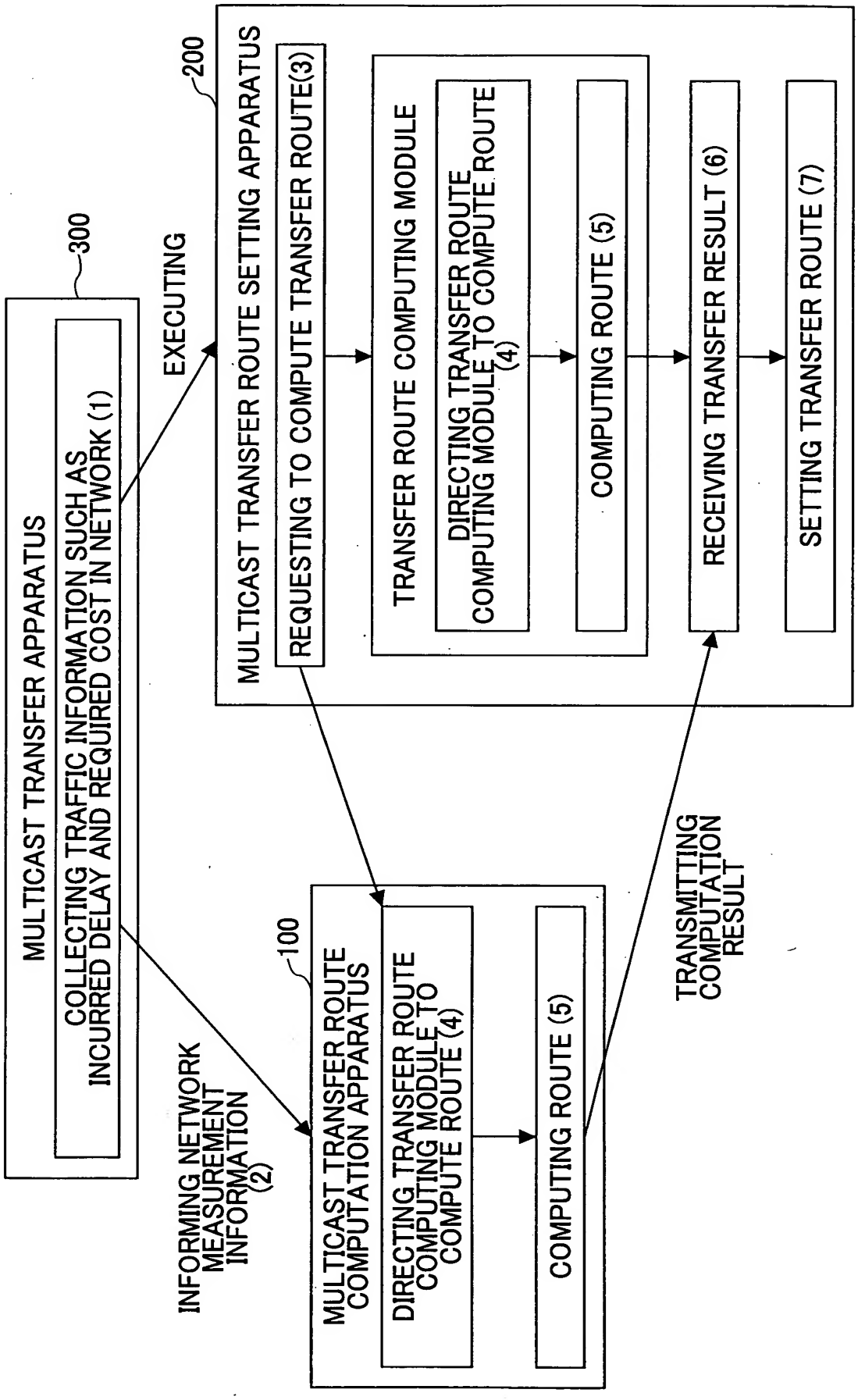

MULTICAST TRANSFER APPARATUS
300
COLLECTING TRAFFIC INFORMATION SUCH AS INCURRED DELAY AND REQUIRED COST IN NETWORK (1)
EXECUTING
200
MULTICAST TRANSFER ROUTE SETTING APPARATUS
REQUESTING TO COMPUTE TRANSFER ROUTE(3)
TRANSFER ROUTE COMPUTING MODULE
DIRECTING TRANSFER ROUTE COMPUTING MODULE TO COMPUTE ROUTE (4)
COMPUTING ROUTE (5)
RECEIVING TRANSFER RESULT (6)
SETTING TRANSFER ROUTE (7)
INFORMING NETWORK MEASUREMENT INFORMATION (2)
100
MULTICAST TRANSFER ROUTE COMPUTATION APPARATUS
DIRECTING TRANSFER ROUTE COMPUTING MODULE TO COMPUTE ROUTE (4)
COMPUTING ROUTE (5)
TRANSMITTING COMPUTATION RESULT

FIG.4

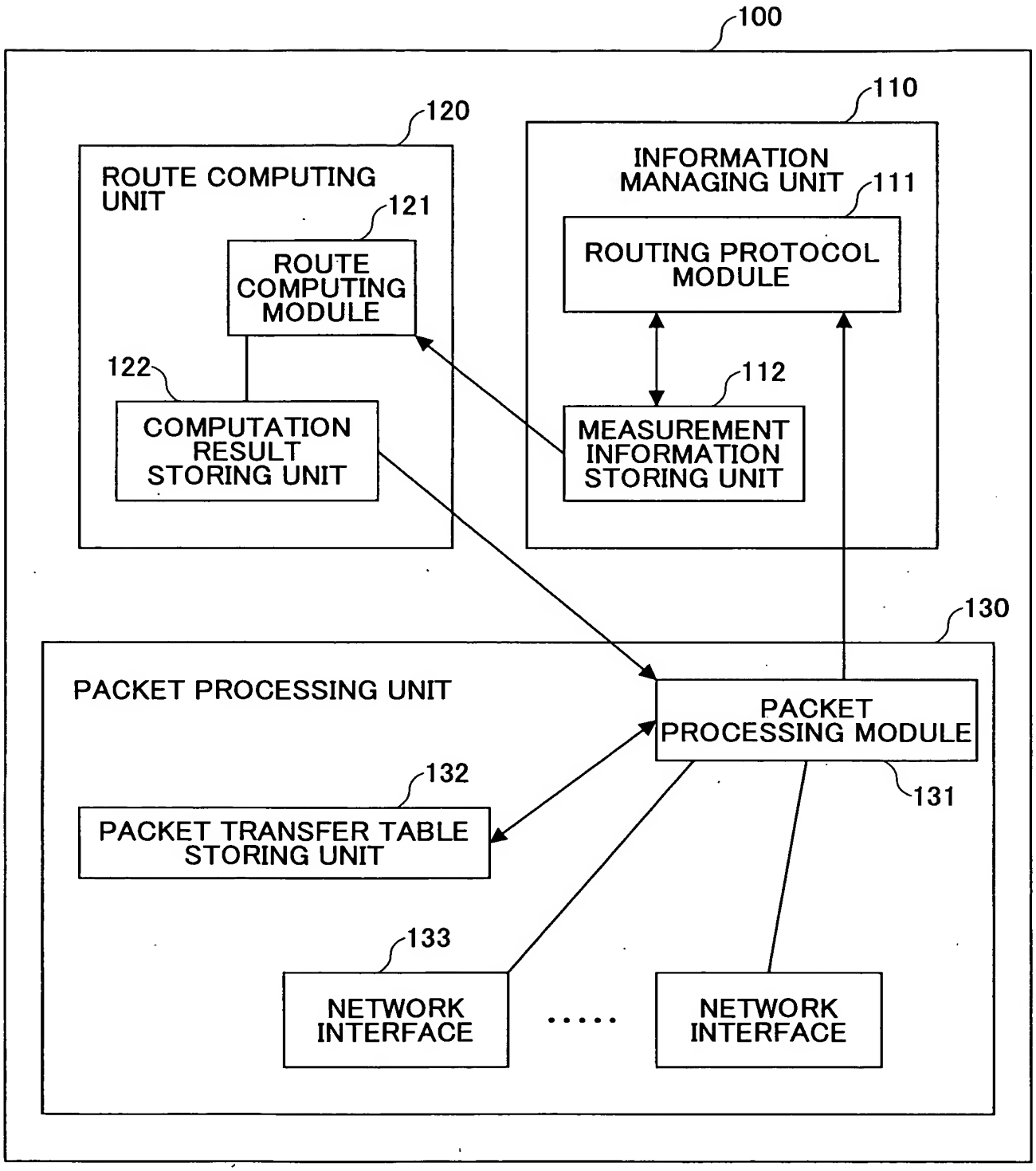

100
110
120
ROUTE COMPUTING UNIT
121
ROUTE COMPUTING MODULE
122
COMPUTATION RESULT STORING UNIT
INFORMATION MANAGING UNIT
111
ROUTING PROTOCOL MODULE
112
MEASUREMENT INFORMATION STORING UNIT
130
PACKET PROCESSING UNIT
PACKET PROCESSING MODULE
131
132
PACKET TRANSFER TABLE STORING UNIT
133
NETWORK INTERFACE
.....
NETWORK INTERFACE

FIG.5

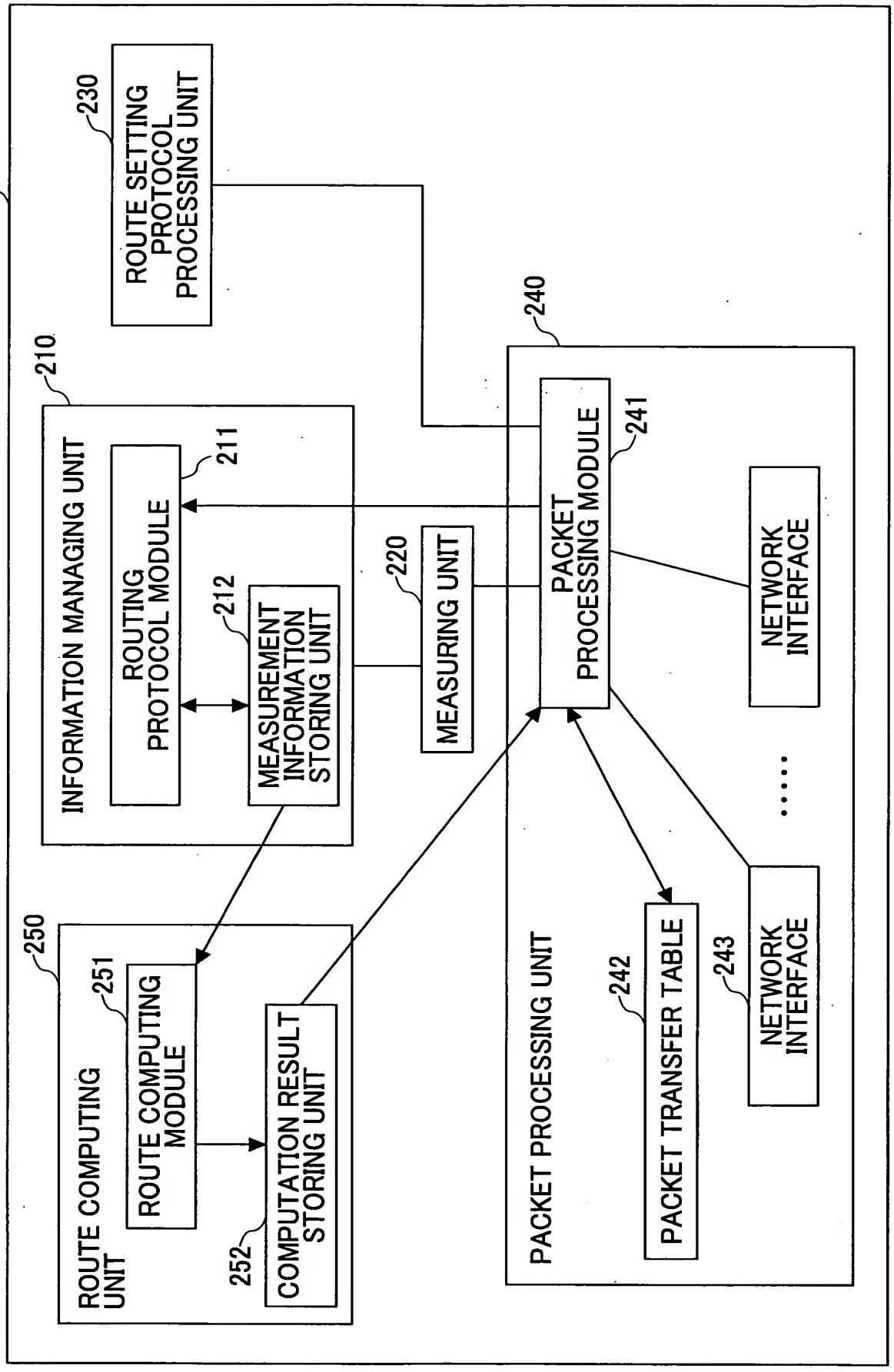

200
230
ROUTE SETTING PROTOCOL PROCESSING UNIT
210
INFORMATION MANAGING UNIT
211
ROUTING PROTOCOL MODULE
212
MEASUREMENT INFORMATION STORING UNIT
220
MEASURING UNIT
240
241
PACKET PROCESSING MODULE
NETWORK INTERFACE
.....
250
ROUTE COMPUTING UNIT
251
ROUTE COMPUTING MODULE
252
COMPUTATION RESULT STORING UNIT
PACKET PROCESSING UNIT
242
PACKET TRANSFER TABLE
243
NETWORK INTERFACE

FIG.6

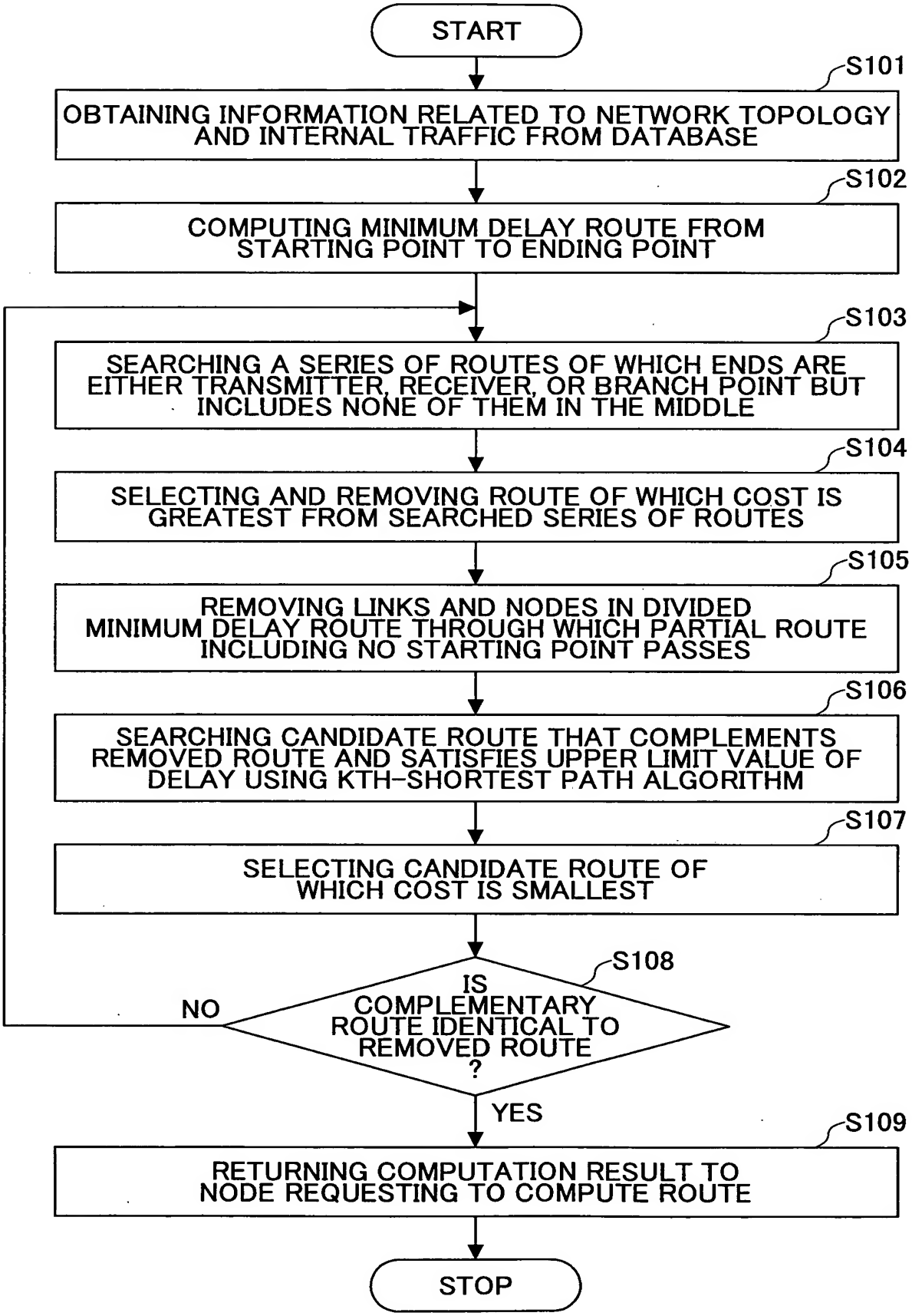
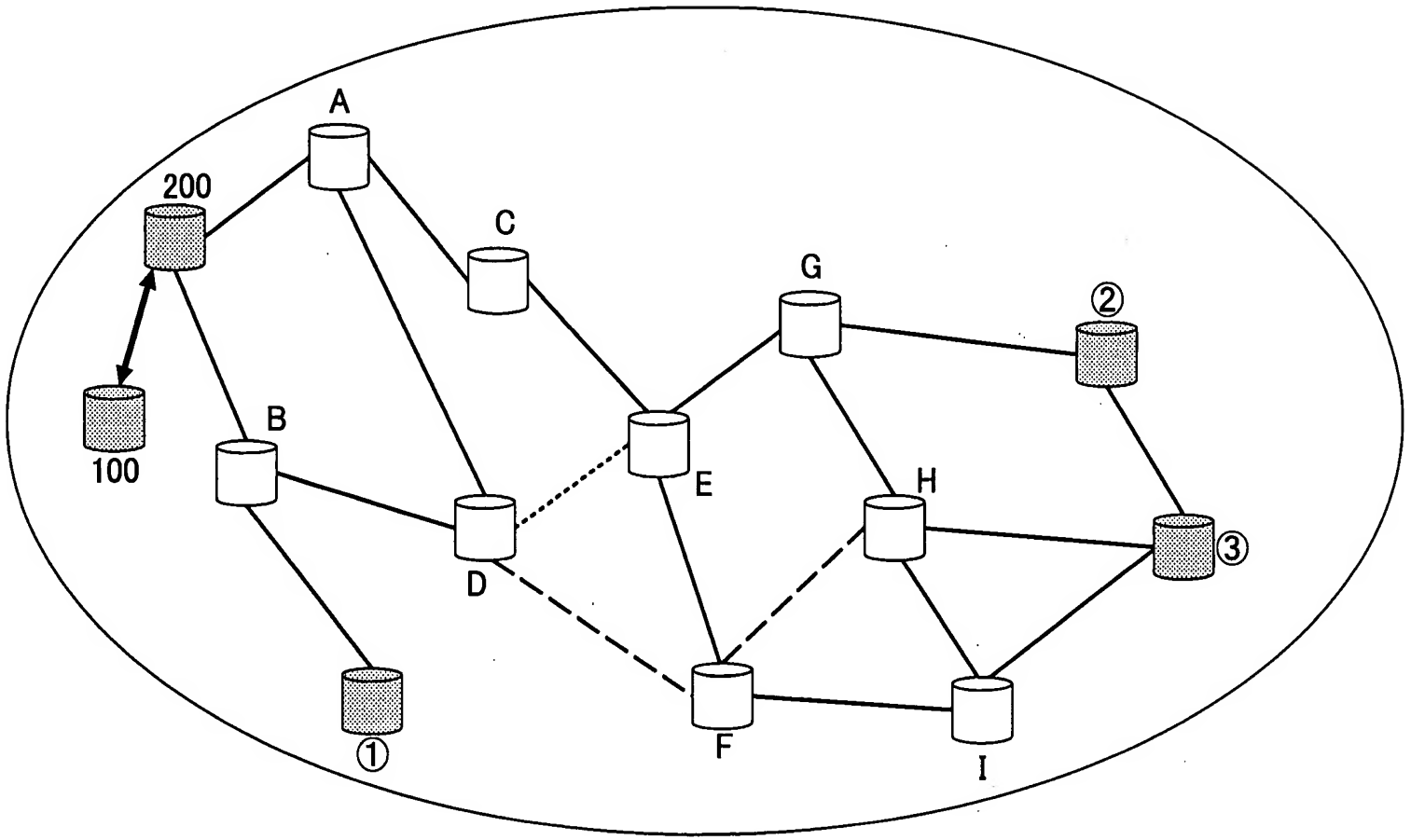

START
S101
OBTAINING INFORMATION RELATED TO NETWORK TOPOLOGY AND INTERNAL TRAFFIC FROM DATABASE
S102
COMPUTING MINIMUM DELAY ROUTE FROM STARTING POINT TO ENDING POINT
S103
SEARCHING A SERIES OF ROUTES OF WHICH ENDS ARE EITHER TRANSMITTER, RECEIVER, OR BRANCH POINT BUT INCLUDES NONE OF THEM IN THE MIDDLE
S104
SELECTING AND REMOVING ROUTE OF WHICH COST IS GREATEST FROM SEARCHED SERIES OF ROUTES
S105
REMOVING LINKS AND NODES IN DIVIDED MINIMUM DELAY ROUTE THROUGH WHICH PARTIAL ROUTE INCLUDING NO STARTING POINT PASSES
S106
SEARCHING CANDIDATE ROUTE THAT COMPLEMENTS REMOVED ROUTE AND SATISFIES UPPER LIMIT VALUE OF DELAY USING KTH-SHORTEST PATH ALGORITHM
S107
SELECTING CANDIDATE ROUTE OF WHICH COST IS SMALLEST
S108
IS COMPLEMENTARY ROUTE IDENTICAL TO REMOVED ROUTE ?
NO
YES
S109
RETURNING COMPUTATION RESULT TO NODE REQUESTING TO COMPUTE ROUTE
STOP

FIG.7

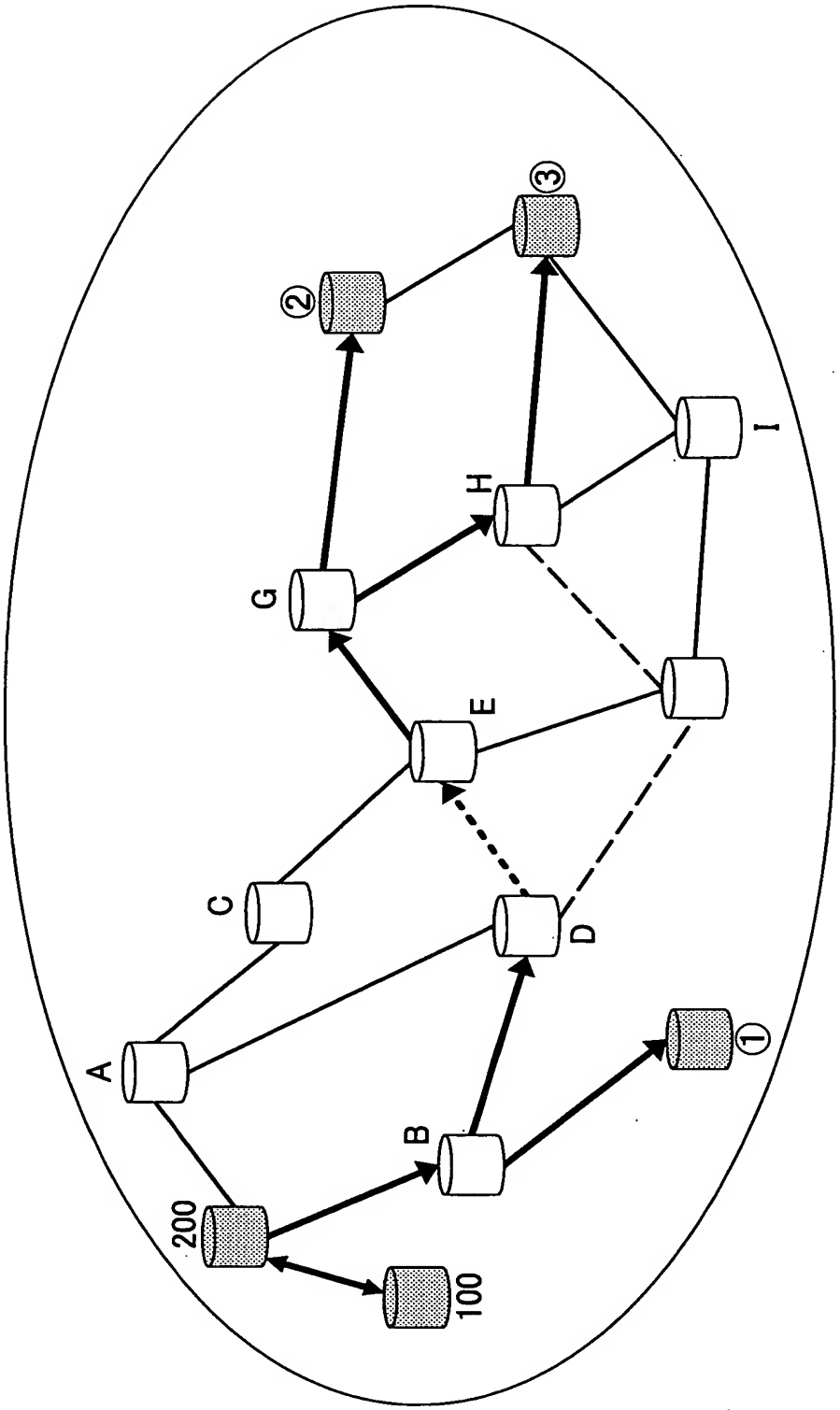


——— (DELAY, COST) = (1, 1) FOR BOTH DIRECTIONS

····· (DELAY, COST) = (1, 10) FOR RIGHT DIRECTION, AND (DELAY, COST) = (1, 1) FOR LEFT DIRECTION

– – – – (DELAY, COST) = (2, 1) FOR RIGHT DIRECTION, AND (DELAY, COST) = (1, 1) FOR LEFT DIRECTION

FIG.8

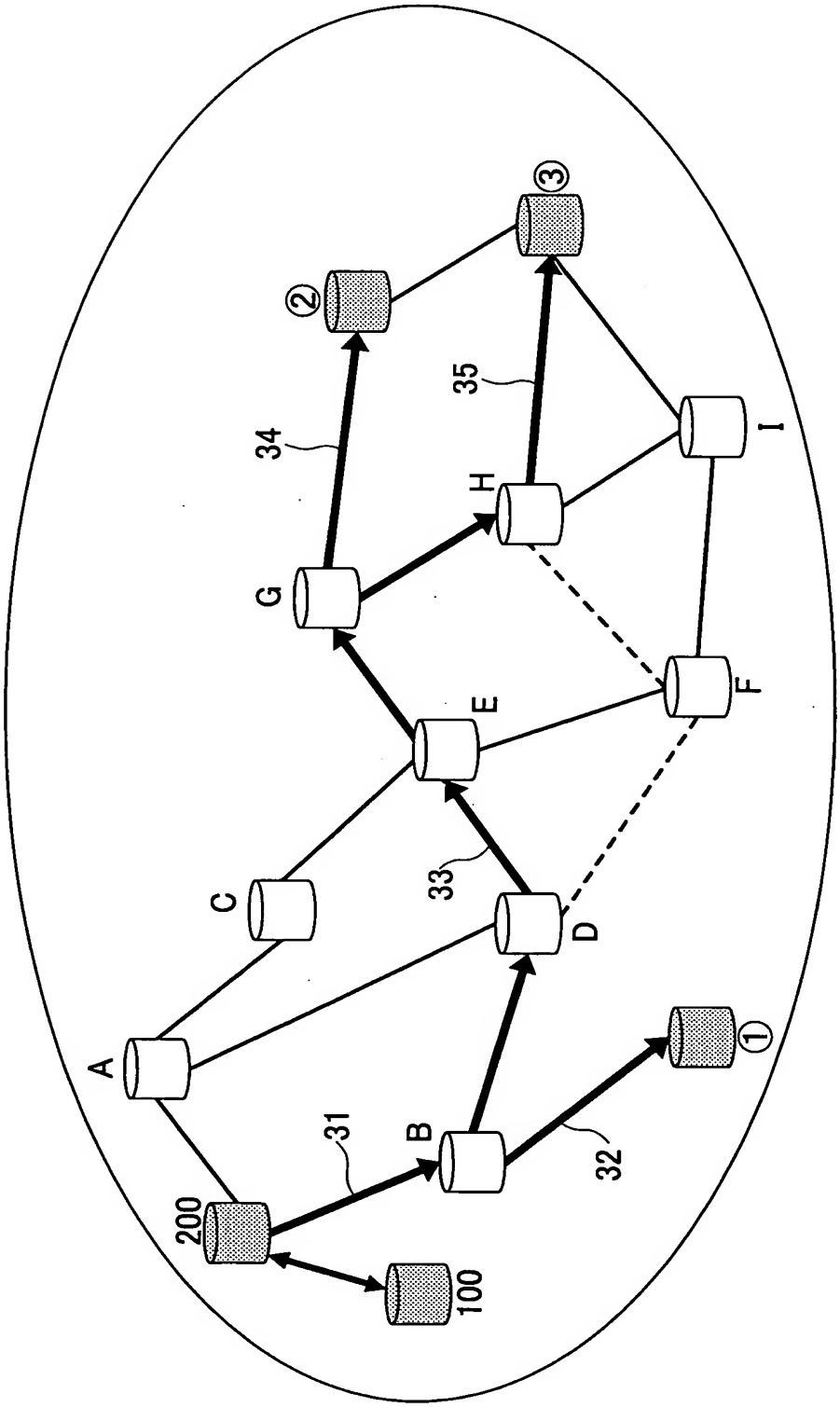


——— (DELAY, COST) = (1, 1) FOR BOTH DIRECTIONS

..... (DELAY, COST) = (1, 10) FOR RIGHT DIRECTION, AND (DELAY, COST) = (1, 1) FOR LEFT DIRECTION

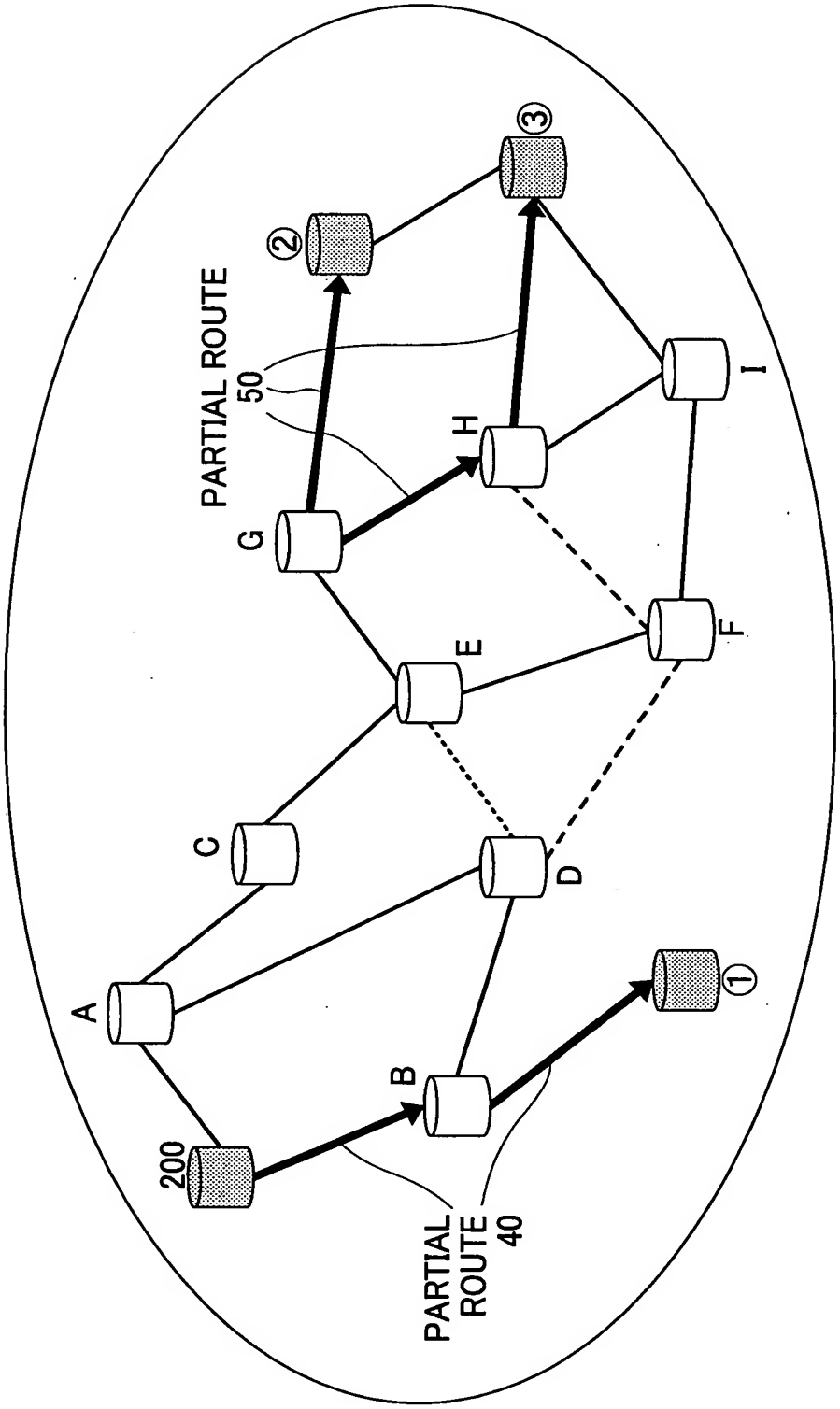
– – – – (DELAY, COST) = (2, 1) FOR RIGHT DIRECTION, AND (DELAY, COST) = (1, 1) FOR LEFT DIRECTION

FIG.9



ROUTE 33 IS TO BE REMOVED SINCE ITS COST IS GREATEST

FIG.10



ROUTE 33 IS TO BE REMOVED SINCE ITS COST IS GREATEST

FIG.11

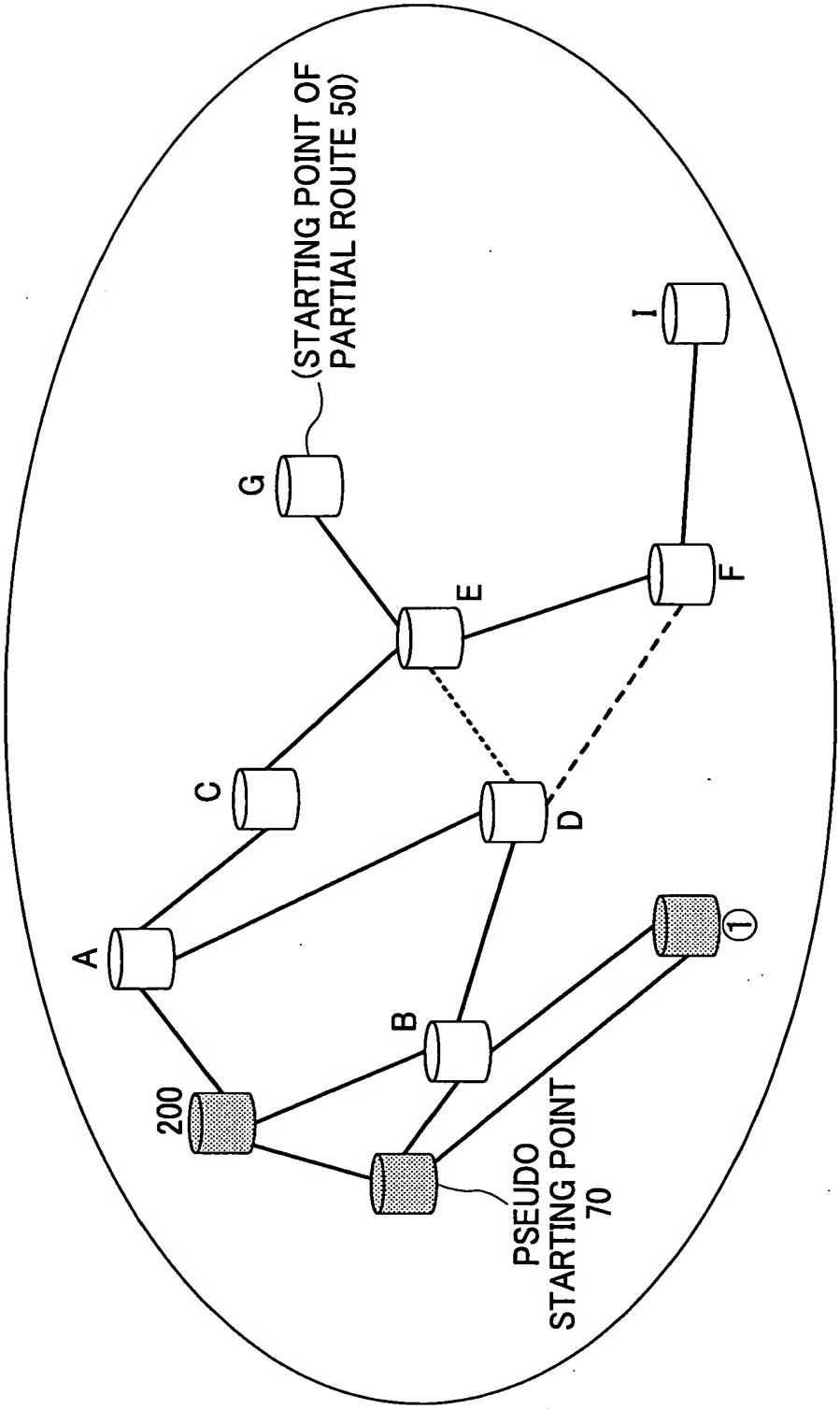

(STARTING POINT OF PARTIAL ROUTE 50)
G
I
E
F
C
D
A
1
B
200
PSEUDO STARTING POINT 70

FIG.12

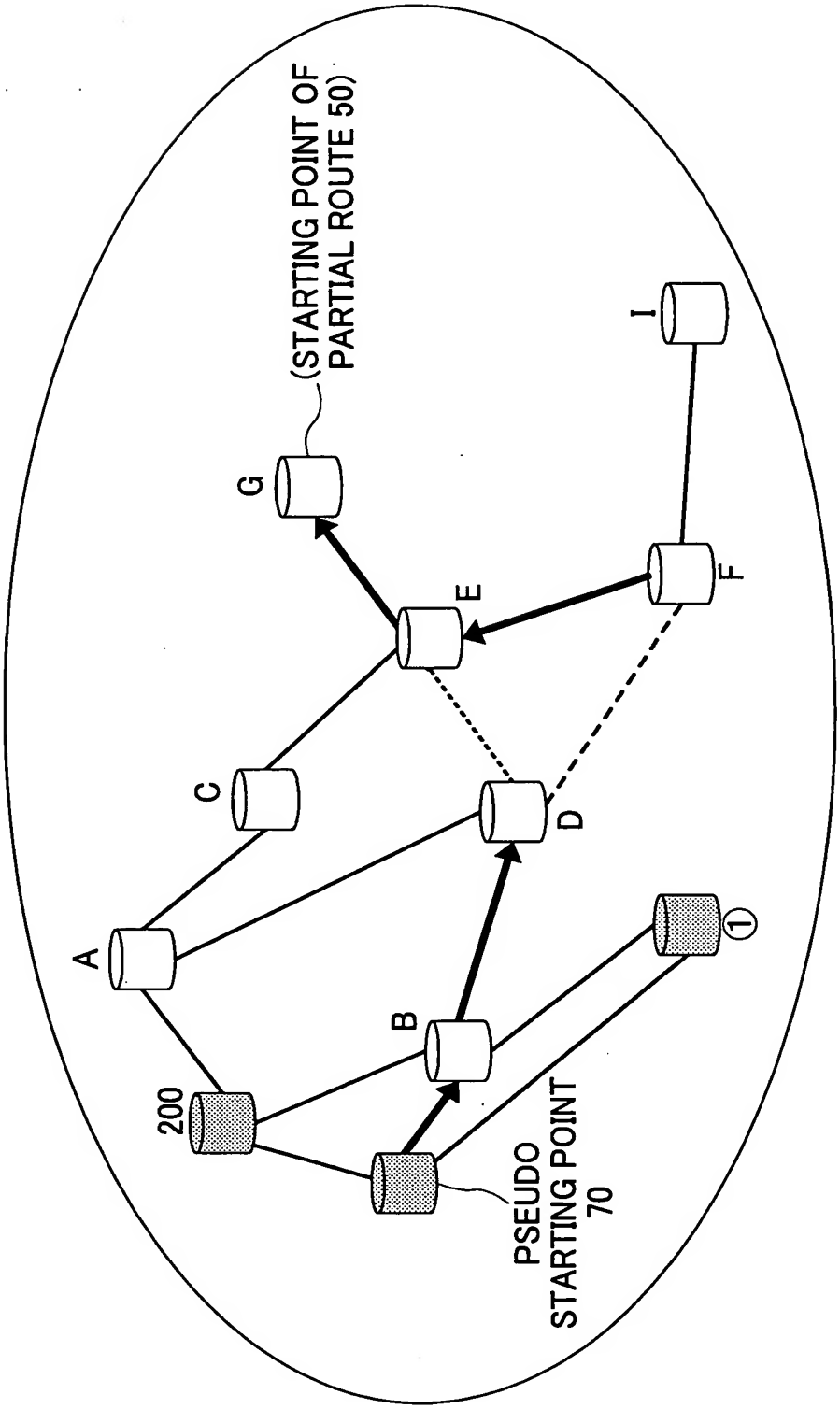
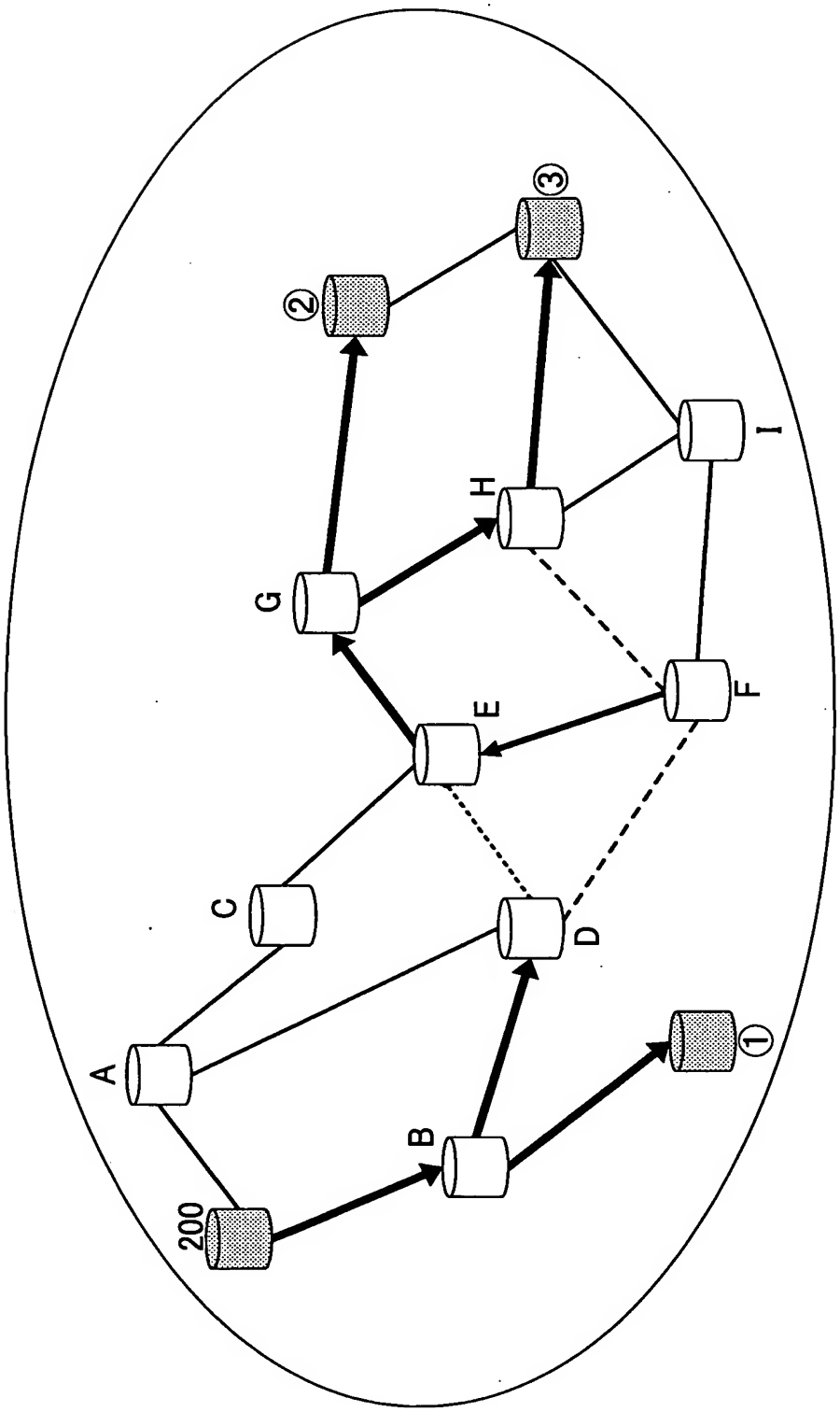

(STARTING POINT OF PARTIAL ROUTE 50)
G
I
E
F
C
D
A
B
1
200
PSEUDO STARTING POINT 70

FIG.13



COST IS REDUCED FROM 17 TO 9

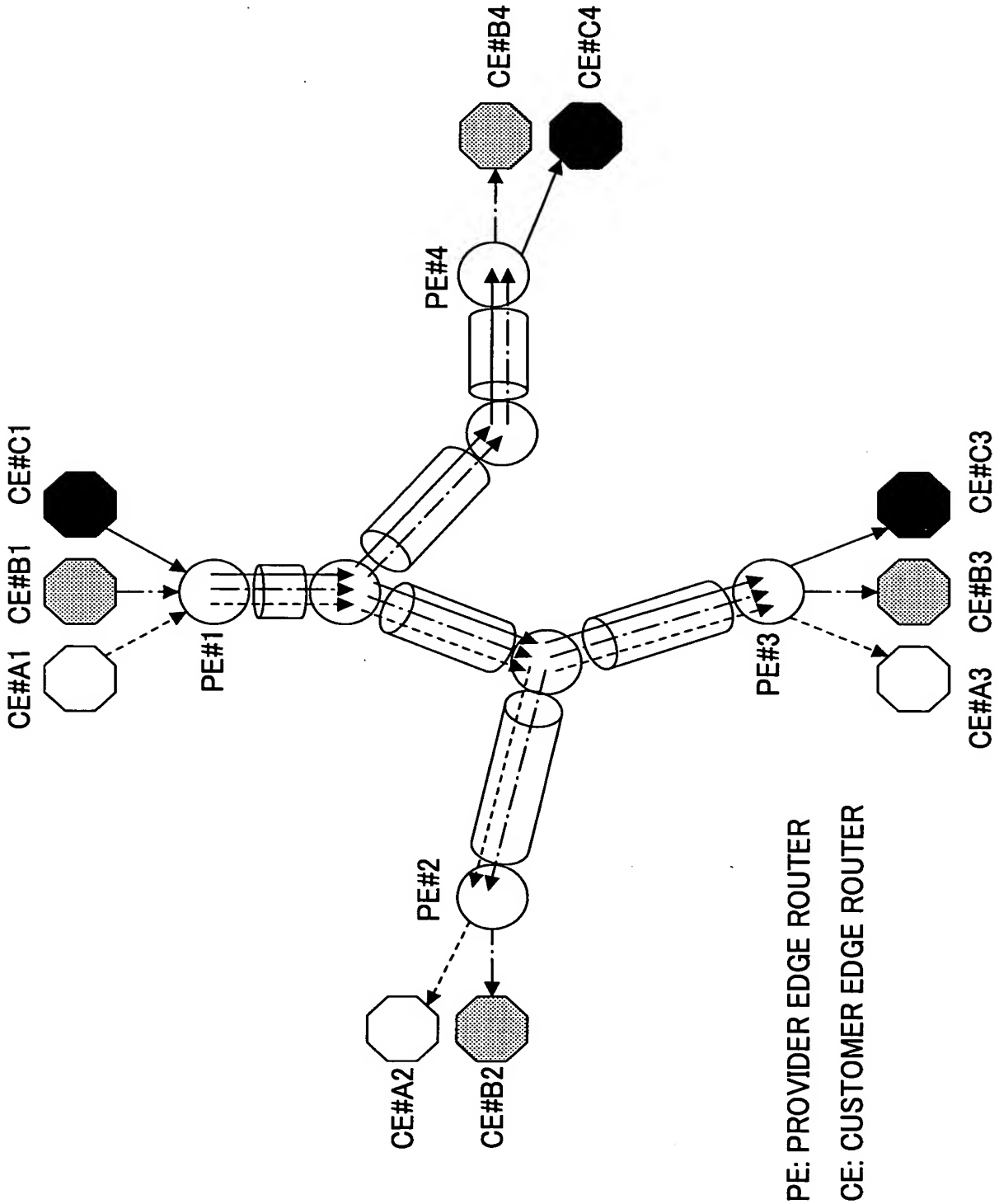
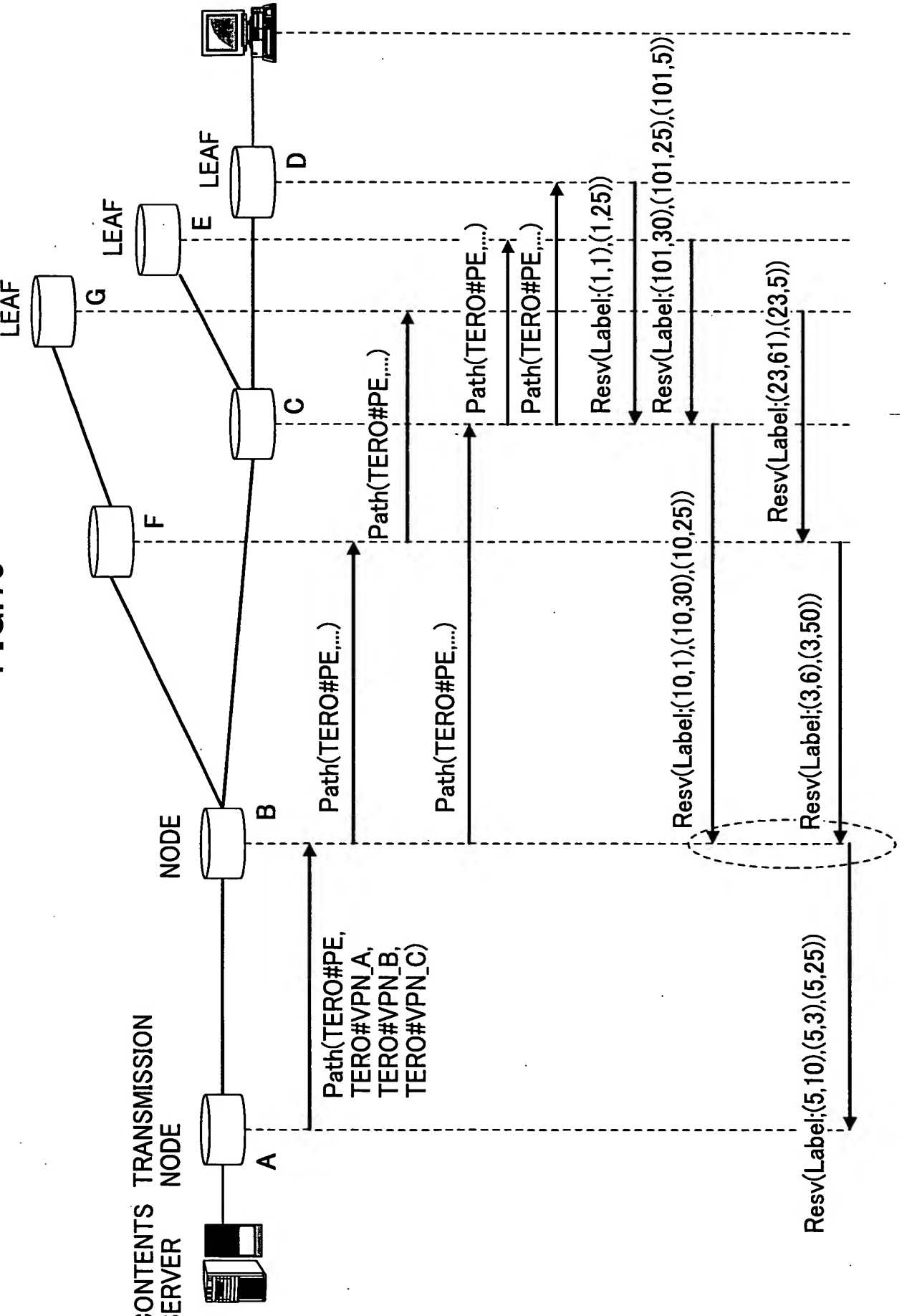

CE#B4
CE#C4
PE#4
CE#C1
CE#B1
CE#A1
PE#1
PE#3
CE#C3
CE#B3
CE#A3
PE#2
CE#A2
CE#B2
PE: PROVIDER EDGE ROUTER
CE: CUSTOMER EDGE ROUTER

FIG.14

FIG.15


CONTENTS SERVER
TRANSMISSION NODE
A
NODE
B
LEAF
F
LEAF
G
LEAF
E
C
D
Path(TERO#PE, TERO#VPN_A, TERO#VPN_B, TERO#VPN_C)
Path(TERO#PE,...)
Path(TERO#PE,...)
Path(TERO#PE,...)
Path(TERO#PE,...)
Resv(Label;(1,1),(1,25))
Resv(Label;(101,30),(101,25),(101,5))
Resv(Label;(10,1),(10,30),(10,25))
Resv(Label;(23,61),(23,5))
Resv(Label;(3,6),(3,50))
Resv(Label;(5,10),(5,3),(5,25))

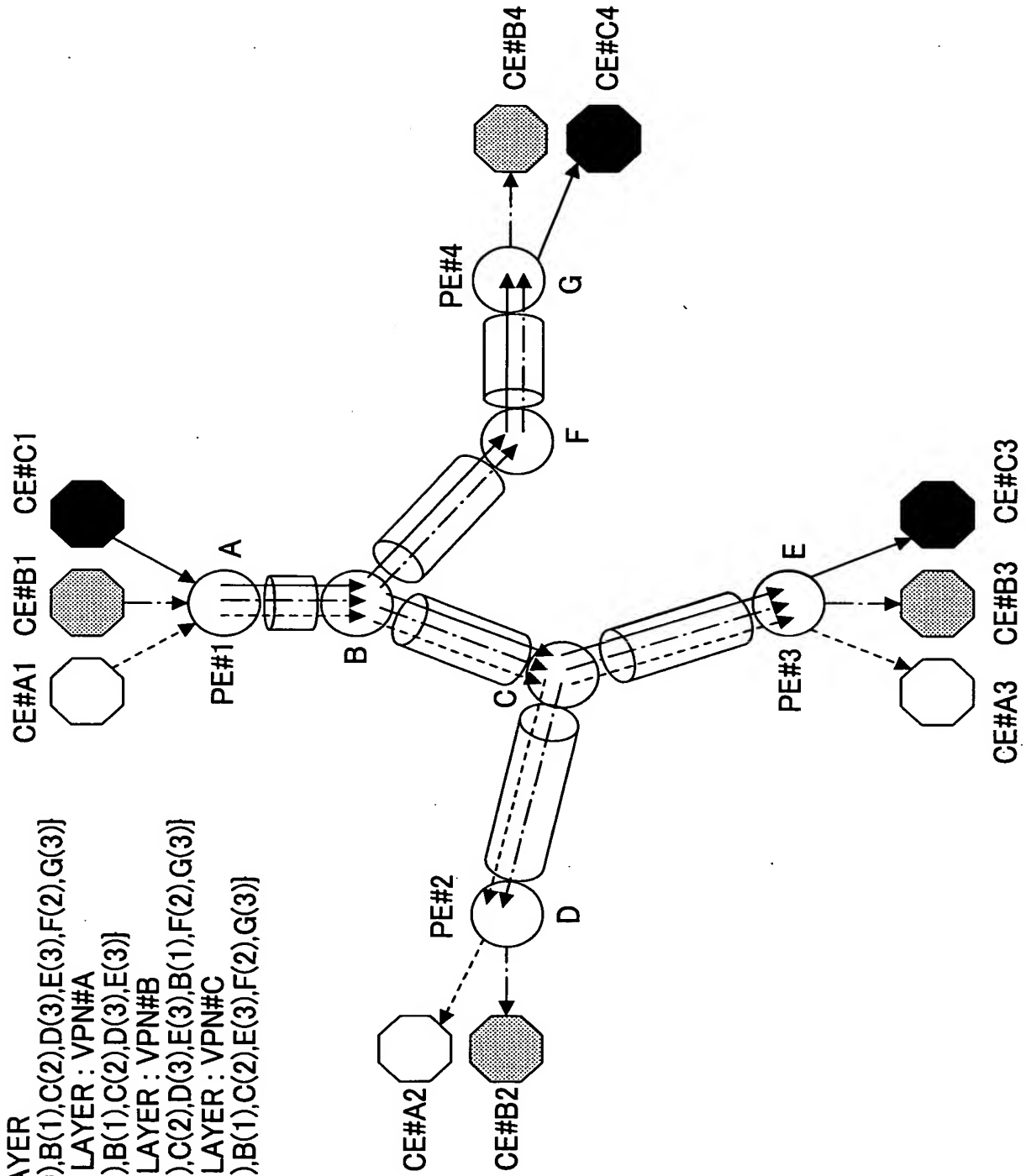

CE#A1
CE#B1
CE#C1
PE#1
A
B
C
D
E
F
G
PE#2
PE#3
PE#4
CE#A2
CE#B2
CE#A3
CE#B3
CE#C3
CE#B4
CE#C4
• FIRST LAYER
TERO={A(0),B(1),C(2),D(3),E(3),F(2),G(3)}
• SECOND LAYER : VPN#A
TERO={A(0),B(1),C(2),D(3),E(3)}
• SECOND LAYER : VPN#B
TERO={A(0),C(2),D(3),E(3),B(1),F(2),G(3)}
• SECOND LAYER : VPN#C
TERO={A(0),B(1),C(2),E(3),F(2),G(3)}

FIG.16

FIG.17

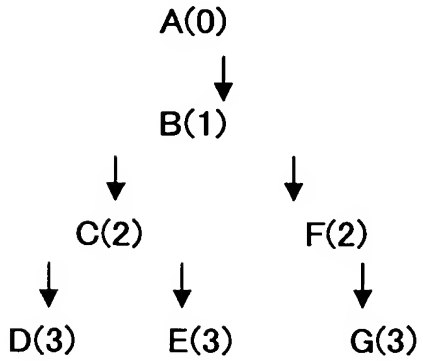
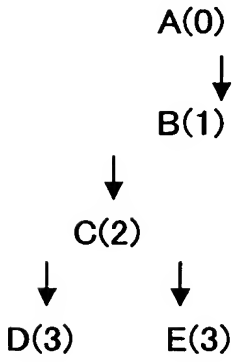


FIG.18



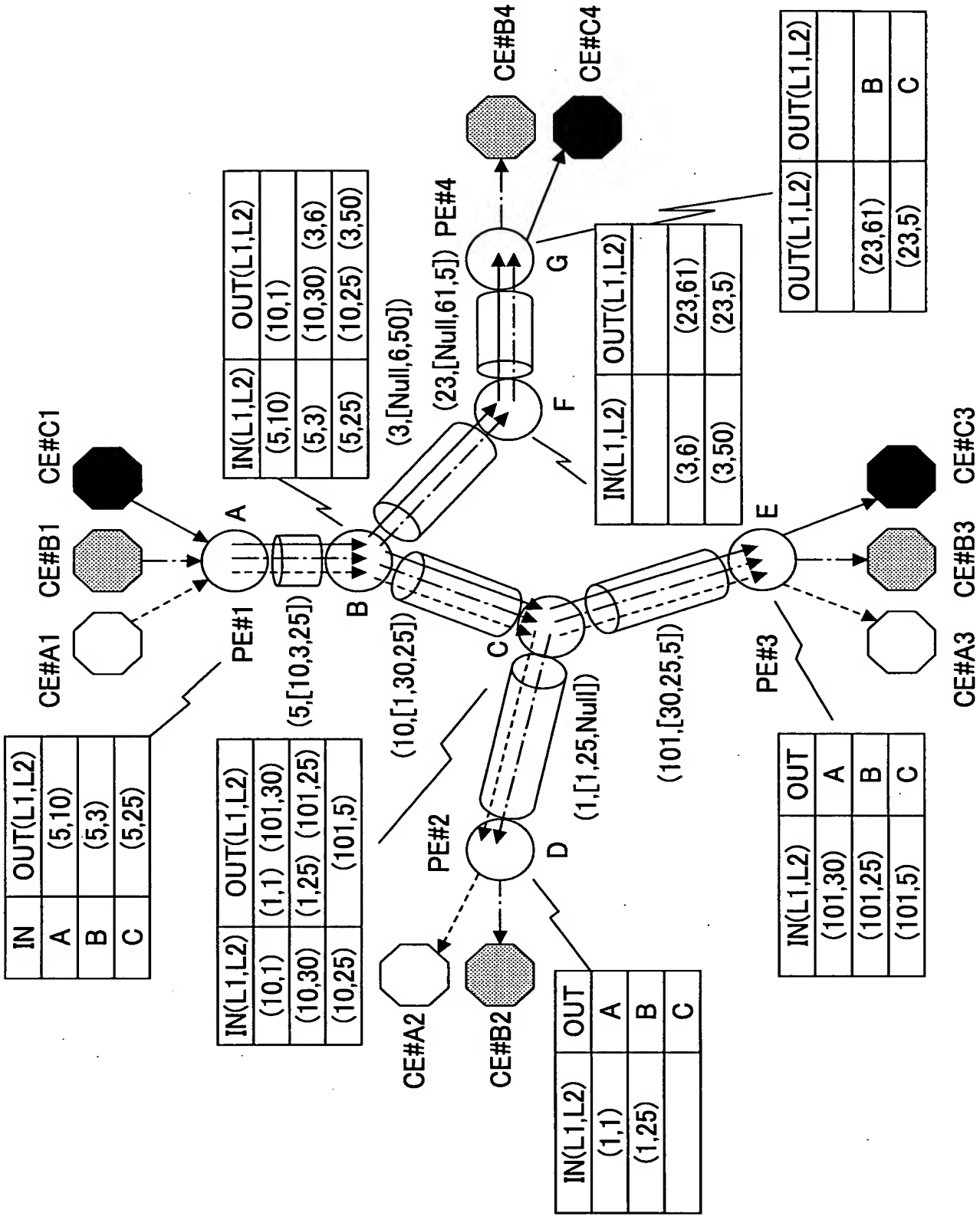

CE#A1
CE#B1
CE#C1
PE#1
A
B
C
D
E
F
G
PE#2
PE#3
PE#4
CE#A2
CE#B2
CE#A3
CE#B3
CE#C3
CE#B4
CE#C4
(5,[10,3,25])
(3,[Null,6,50])
(23,[Null,61,5])
(10,[1,30,25])
(1,[1,25,Null])
(101,[30,25,5])
IN | OUT(L1,L2)
A | (5,10)
B | (5,3)
C | (5,25)
IN(L1,L2) | OUT(L1,L2)
(5,10) | (10,1)
(5,3) | (10,30) (3,6)
(5,25) | (10,25) (3,50)
IN(L1,L2) | OUT(L1,L2)
(10,1) | (1,1) (101,30)
(10,30) | (1,25) (101,25)
(10,25) | (101,5)
IN(L1,L2) | OUT(L1,L2)
(3,6) | (23,61)
(3,50) | (23,5)
OUT(L1,L2)
B
C
(23,61)
(23,5)
IN(L1,L2) | OUT
(101,30) | A
(101,25) | B
(101,5) | C
IN(L1,L2) | OUT
(1,1) | A
(1,25) | B
C

FIG.19

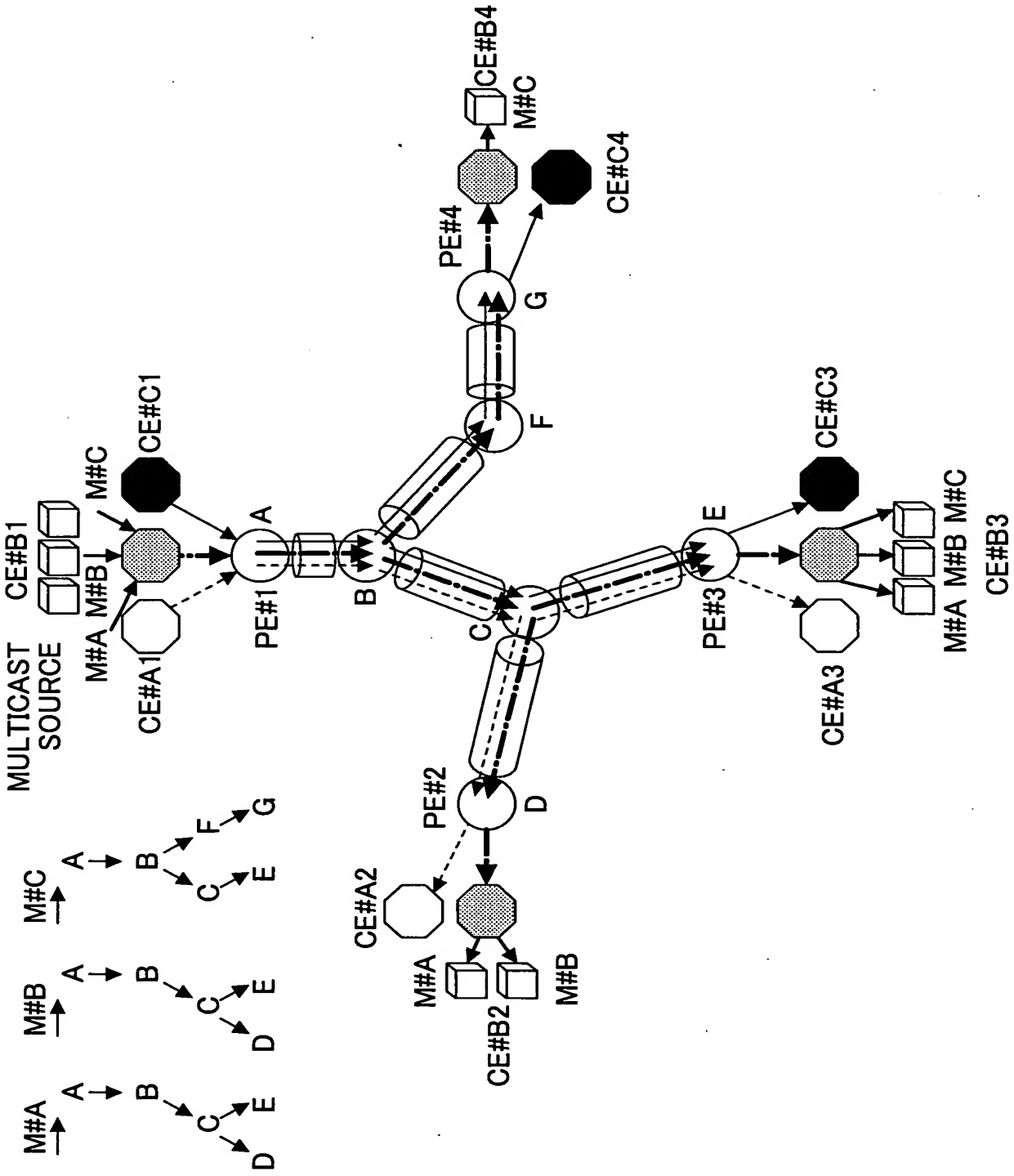

MULTICAST SOURCE
CE#A1
M#A
M#B
M#C
CE#B1
CE#C1
PE#1
A
B
C
D
E
F
G
PE#2
PE#3
PE#4
CE#A2
CE#A3
CE#B2
CE#B3
CE#B4
CE#C3
CE#C4
M#A
M#B
M#A M#B M#C
M#C
M#B
M#A

FIG.20

FIG.21

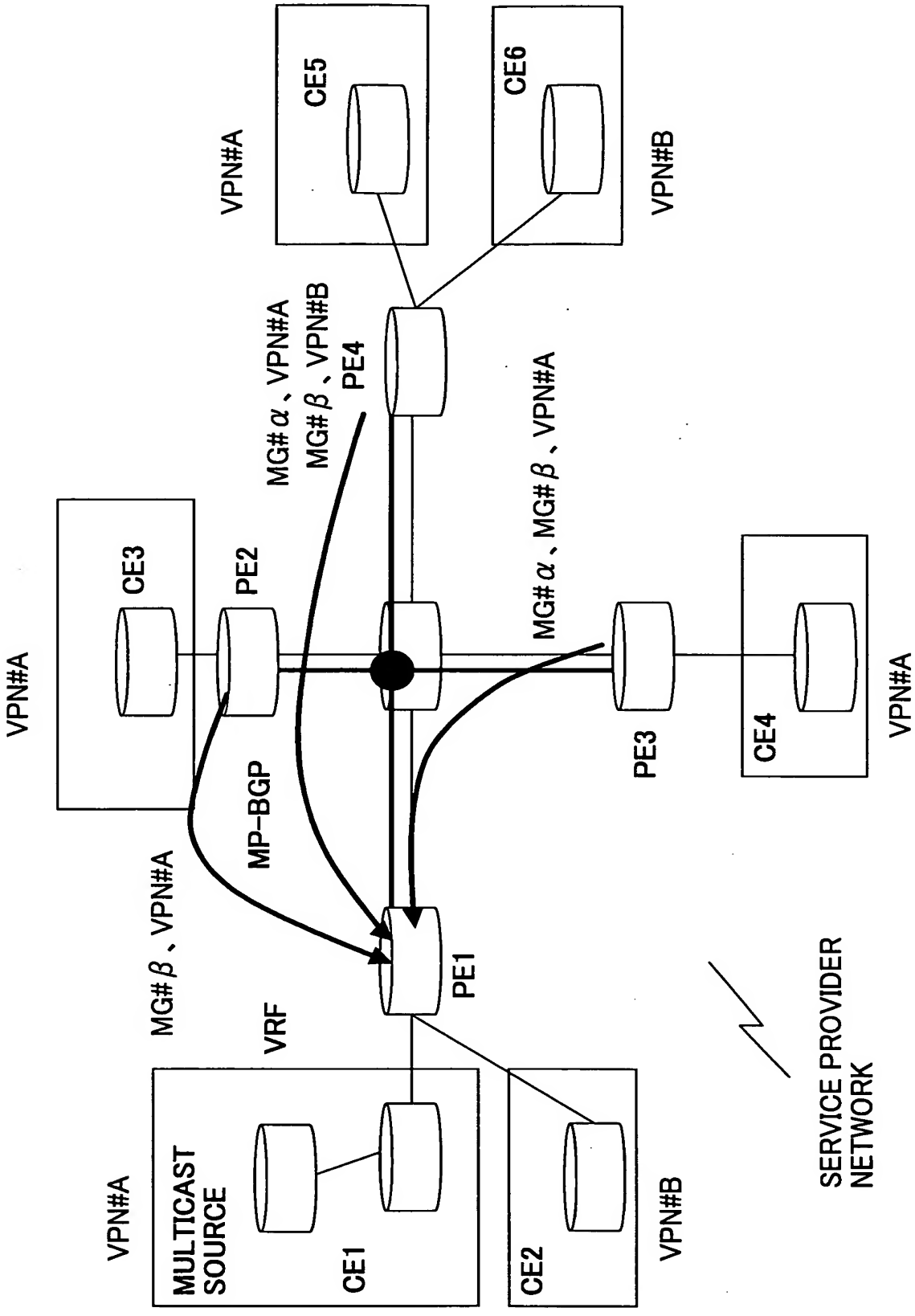

VPN#A
CE5
CE6
VPN#B
MG# α 、VPN#A
MG# β 、VPN#B
PE4
VPN#A
CE3
PE2
MG# α 、MG# β 、VPN#A
PE3
CE4
VPN#A
MP-BGP
MG# β 、VPN#A
VRF
PE1
SERVICE PROVIDER NETWORK
VPN#A
MULTICAST SOURCE
CE1
CE2
VPN#B

FIG.22

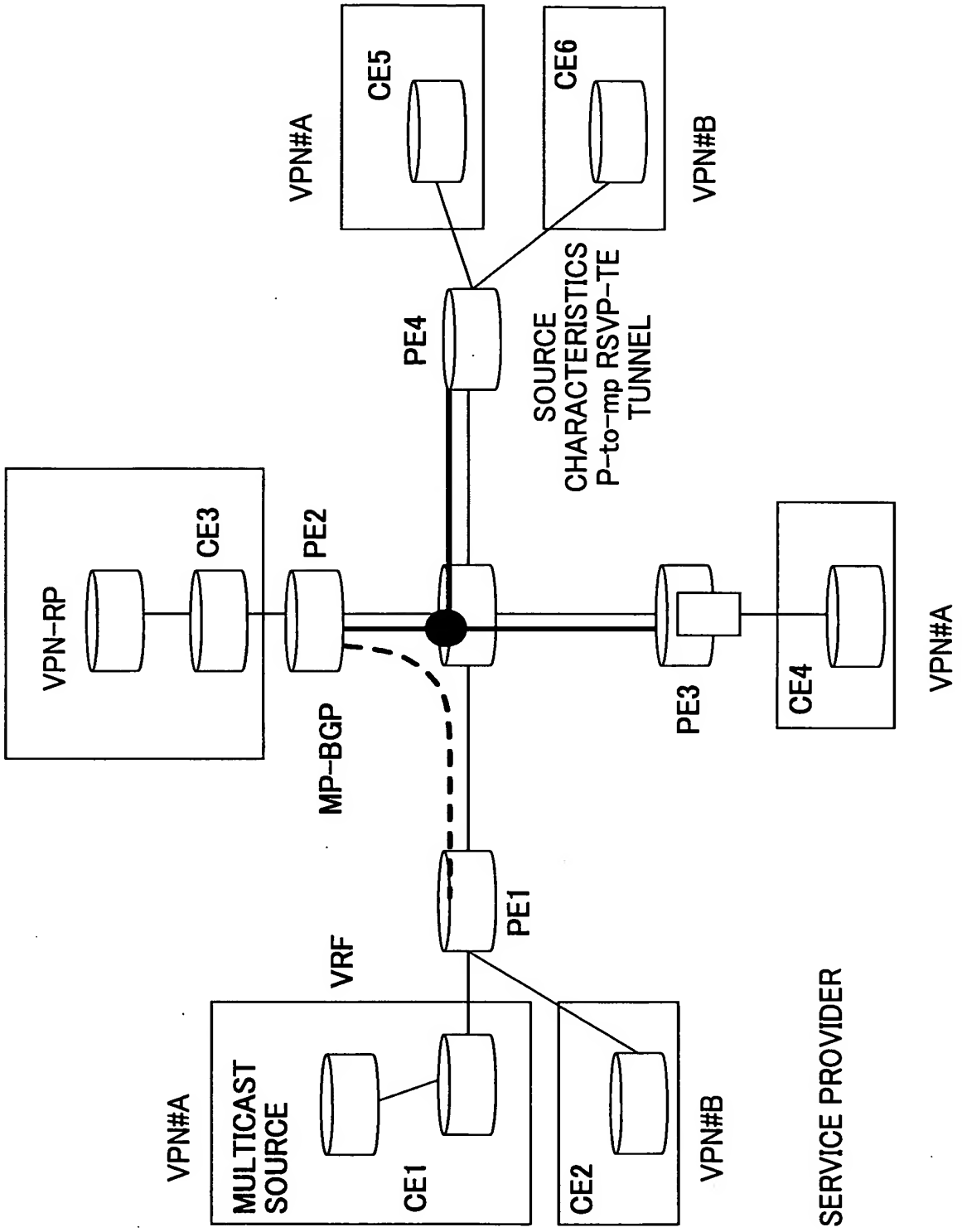
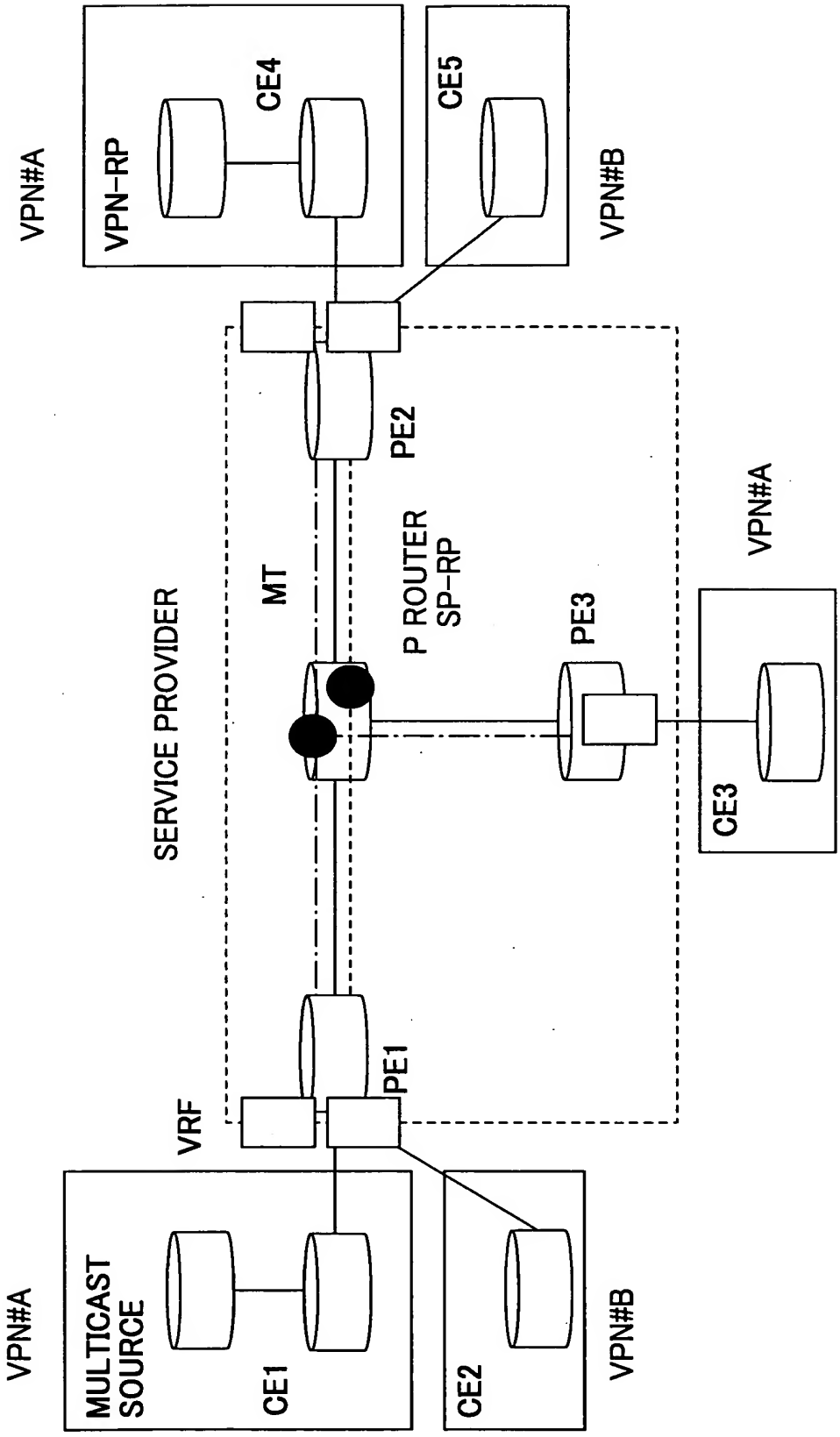

VPN#A
CE5
CE6
VPN#B
PE4
SOURCE CHARACTERISTICS P-to-mp RSVP-TE TUNNEL
VPN-RP
CE3
PE2
PE3
CE4
VPN#A
MP-BGP
VRF
PE1
VPN#A
MULTICAST SOURCE
CE1
CE2
VPN#B
SERVICE PROVIDER

FIG.23


VPN#A
VPN-RP
CE4
CE5
VPN#B
PE2
MT
P ROUTER
SP-RP
PE3
VPN#A
SERVICE PROVIDER
CE3
VRF
PE1
VPN#A
MULTICAST
SOURCE
CE1
CE2
VPN#B

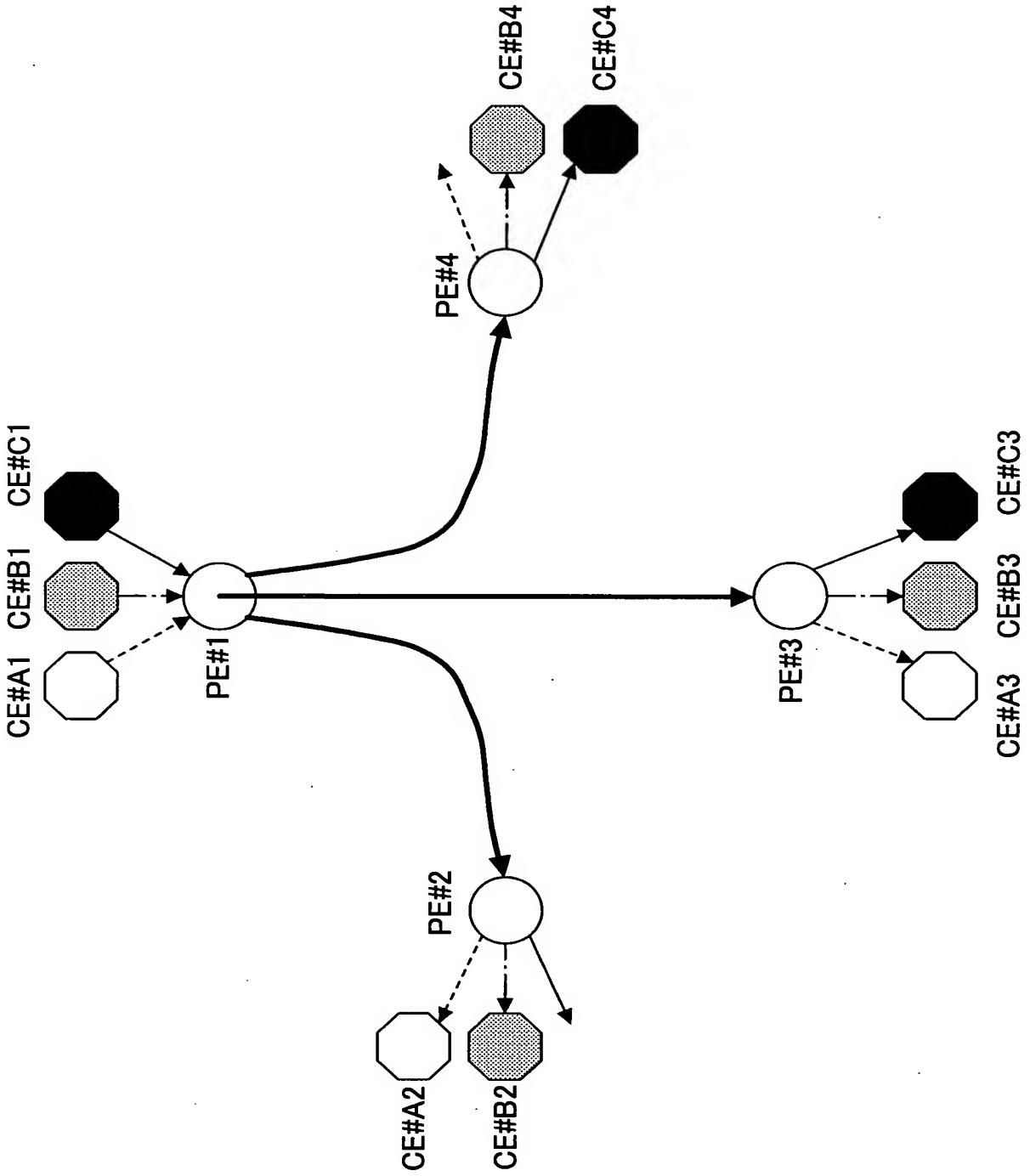

CE#C1
CE#B1
CE#A1
PE#1
CE#B4
CE#C4
PE#4
PE#2
CE#A2
CE#B2
PE#3
CE#C3
CE#B3
CE#A3

FIG.24